

Knee Laxity Variations in the Menstrual Cycle in Female Athletes Referred to the Orthopedic Clinic

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Abstract

Background: Anterior cruciate ligament (ACL) rupture is the biggest concern for orthopedic surgeons who are involved in sports injuries, so most of ACL reconstruction surgeries are sports related. ACL injuries in female athletes are 2 - 8 times more common than male athletes in similar sport injuries.

Objectives: The aim of this study was to compare knee laxity changes in the menstrual cycle in female athletes referred to the orthopedic clinic of Imam Khomeini hospital in the north of Iran, Sari, 2013.

Patients and Methods: The present descriptive study was conducted on 40 female athletes that were referred to the orthopedic clinic. Hormone levels, such as estrogen and progesterone were assessed by one laboratory in 3 phases of the menstrual cycle. We used Lachman test and anterior drawer test for knee laxity rate. The descriptive statistics were calculated as indices of central distribution of bonds ($x \pm SD$) and relative frequency distribution was used for qualitative variables.

Results: The results of the current study showed that there is no significant difference in ACL laxity in female athletes in three phases of menstrual cycle; namely menstruation time, ovulation time and mid-luteal phase.

Conclusions: Despite numerous studies and research in the field of knee laxity and effects of female hormones, many researchers do not agree about the effect of female hormones on knee laxity. The current study also reported no relationship between female hormones and knee laxity, while statistics show fundamental difference between male and female athletes.

Keywords: Knee, Joint laxity, Athletes, Menstrual Cycle

1. Background

Knee ligament injury is one of the most common sports injuries that impose a high socio-economic burden on patients and society. Anterior cruciate ligament (ACL) rupture is the biggest concern for orthopedic surgeons who are involved in sports injuries and most of ACL reconstruction surgeries are related to sport (1). This is especially important in female athletes, since the statistics show that the ACL injuries in female athletes are 2 - 8 times more common than male athletes in sports injuries (2-5). Several factors increase the likelihood of the rate of ligament laxity. These risk factors include anatomical problems, hormonal and biomechanical factors as well as neuromuscular differences in patients (6, 7). Increased joint laxity is another risk factor in injured ACL in women rather than men and it is believed that knee laxity causes changes in biomechanical factors that increase the pressure on knee ligaments and increase the rate of ACL rupture (2, 8, 9). Previous stud-

ies showed that the ACL laxity and the menstrual cycle estrogen and progesterone levels are significantly associated with each other (2, 4, 6, 9-11). Knee ligament laxity is defined as the displacement difference of more than 5 mm or 3 mm between healthy and damaged knee. The knee joint is perhaps the largest and most complex joint in the human body structure. It is not surprising that the results show that the knee joint is the most vulnerable to injuries among the joints (9, 10). Several studies showed that female hormones cause an increase of knee laxity in females more than males, thus they can be a cause of increased ACL injuries in females, especially in the menstruation phase (2, 4, 6, 9, 10). Mean while, one study showed that taking birth control pills in soccer players decreases the rate of ACL laxity by decreasing the hormonal changes (8). However, some studies revealed that there is no significant difference between ACL laxity and menstruation cycle phases and their hormone levels (3, 12-17).

2. Objectives

Due to the high incidence of ACL injuries in patients referred to orthopedic clinics, different results in the field of assessment of ACL laxity and female hormone levels, lack of a detailed study in knee biomechanics and joint laxity, difference in region of performing the study and lack of examination time and hormone assay in menstruation cycle, we decided to conduct a study with the title of assessing changes of knee laxity with menstrual cycle phases in female athletes to identify the reasons and comparison of our results with other recent studies in this field, and find out the best prevention methods such as decreasing heavy sports activity in parts of the menstruation cycle to avoid the increasing rate of injury due to knee laxity.

3. Patients and Methods

This descriptive survey was conducted on 40 female athletes. The samples included 40 female patients with 70% incidence and 40% accuracy, selected using simple randomized method among female athletes referred to the orthopedic clinic of Imam Khomeini hospital in Sari in 2013. All patients had regular menstruation cycles, no pregnancy history and no knee injury, and they were between 15 - 30 years old. Females who had history of knee fracture or surgery, had taken oral contraceptives in the past 6 months, were less than 15 or more than 30 years or had systemic disease in past medical history that interfered in lab measurement of female hormone levels such as thyroid diseases and finally did not want to participate in our survey were excluded from this study. Ligament laxity in menstruation phase, ovulation time and middle of luteal phase were evaluated by a knee surgeon. In addition, hormone levels such as estrogen and progesterone were assessed in a laboratory using ELISA and DEMEDITEC kits in the 3 abovementioned periods. The time of ovulation can be specified based on urinary LH kits. We used Lachman test and anterior drawer test for knee laxity rate.

3.1. Statistical Analysis

Data was collected for statistical calculation of the central and dispersion parameters. Descriptive statistics were calculated as indices of central distribution of bonds ($\bar{x} \pm SD$) and relative frequency distribution was used for qualitative variables. Data was analyzed using SPSS version 18.0 and we could evaluate variations in knee laxity in menstrual cycle in our patients. P value less than 0.05 were considered significant.

4. Results

In this study the mean age of participants was 25.5 ± 5.12 years. 60% of subjects had 5 day menstrual cycles, 30% had 6 days and 10% had a four days of menstruation cycle (Table 1). Generally, average length of menstrual cycle in patients attending was 5.27 ± 0.59 days. 50% of our patients were employees, 20% housewives and 15% students. 50% of patients who were participated in the study were involved in volleyball, 20% aerobics, 15% taekwondo, 5% wushu, 5% basketball and finally 5% ballet activity (Table 2).

90% of patients, exercised for 6 hours weekly and others for 4 hours a week. The mean of time of sport activity in a week was 4.2 ± 0.6 hours. The mean BMI of patients in this study was 21.9 ± 1.47 . The minimum and maximum BMI in our study was 19 and 24. After collecting the data using a questionnaire and analyzing it with statistical tests, we concluded that there is no significant difference in ACL laxity between 3 phases of menstrual cycle, such as menstruation phase, ovulation time and middle of luteal phase ($P = 0.67, 0.43$ and 0.49 , respectively). In addition, there was no significant difference in ACL laxity and female hormone level variations in our patients ($P = 0.138, 0.83$ and 0.7 , respectively) (Table 3). On the other hand, we found that there is no significant relationship between the phases of menstrual cycle and knee joint laxity which was assessed by knee surgeon and also female hormone level variations in menstrual cycle did not have any significant relation with ACL laxity; therefore we cannot prevent female athletes from doing sports activity in menstruation time because of knee laxity.

5. Discussion

Perhaps the largest and most complex joint in human body is the knee joint, and knee ligament injury is one of the most common sports injuries, specially seen in ACL that has a higher prevalence of tearing and it is the greatest concern of orthopedic surgeons who are involved in sports injuries. In the current study, we decided to investigate the effects of estrogen and progesterone hormones on knee joint laxity. Park, Bonci, Alentorn, Hewett and Slauterbeck believed that the ACL laxity and the menstrual cycle estrogen and progesterone levels are significantly associated (2, 4, 9-11). According to their studies, the rate of knee laxity increased during menstruation and variations in female hormone levels. Thus, these five studies suggest that reduction of sport activity during menstruation while the ligaments are too vulnerable to injuries and one of the most important prevention options from knee ligament injuries is decreasing the time of severe sport activity. In addition, the study by Heitz reported a significant increase

Table 1. Demographic Features of Our Patients

Demographic Features	Mean \pm SD
Mean age (y)	25.5 \pm 5.12
Length of menstrual cycle (days)	5.27 \pm 0.59

Table 2. Hormone Serum Levels in Our Patients Based on the Menstruation Phases

Menstruation cycle	Progesterone (ng/ml)	Estradiol (pg/ml)	P Value	P Value in ACL Laxity ^a (Lachman)
Menstruation phase	25.3 \pm 2.83	42.7 \pm 4.28	0.67	0.67
Ovulation time	78.47 \pm 3.31	149.36 \pm 16.92	0.43	0.83
Luteal phase	121.44 \pm 11.56	175.34 \pm 13.71	0.49	0.7

^aThere are no laxity.

Table 3. Patients Percentage Based on The Sport Fields

Sport Fields	Percent
Volleyball	50
Aerobic	20
Taekwondo	15
Wushu	5
Basketball	5
Ballet activity	5

in ACL laxity occurring in conjunction with the approximate time of ovulation and pre-ovulation and an increase in laxity during the mid-luteal peak in estrogens and progesterone (14). Some of these authors such as Yu and Park revealed that the reason of laxity during menstruation is not hormone changes. For example Yu found that the relative decrease in type I pro collagen synthesis with increasing estradiol concentrations may cause ligament weakening and finally knee laxity (15, 16). Park in another study said that a higher knee joint load with movement during menstrual cycle is the cause of knee laxity (17). The results of our study were contradictory to other results, since this study reported no relationship between female hormones and knee laxity. This discrepancy might be due to the method of evaluation. We examined knee laxity difference by knee surgeon and physical examinations and Heitz examined the laxity difference at 133 N and other studies used the KT-2000 or radiographic measures (14). Another reason could be testing ovulation time using ovulation kits, which could cause differences in detecting accurate time of ovulation. On the other hand, we found no differences between knee joint laxity measures and the phase of the menstrual cycle. In addition, some studies revealed

that there is no significant difference between ACL laxity, menstruation cycle phases and their hormone levels that was similar to the results of our study (3, 12, 18-20). Examples include a study by Beynnon, Eiling and Hertel which revealed that female hormone fluctuations had no significant effect on knee laxity and that joint and knee laxity do not change during the menstrual cycle (3, 19, 20). We suggest this investigation to be conducted in a larger sample size throughout the entire menstrual cycle, which could be beneficial to identifying accurate and perfect results. In addition, future investigations should include neuromuscular, bio mechanical and molecular fields of knee problems to give a better understanding of these affects.

Footnotes

Authors' Contribution: Study concept and design: Sepideh Peyvandi, and Seyed Esmaeel Shafiei; acquisition of data: Seyed Mohamad Mehdi Daneshpoor, Zeynab Aghajantabar; analysis and interpretation of data: Masoud Shayesteh azar; drafting of the manuscript: Mohamad Hosein Kariminasab; critical revision of the manuscript for important intellectual content: Seyed Mohamad Mehdi Daneshpoor; Statistical analysis: Alireza Khalilian; administrative, technical, and material support: Sepideh Peyvandi, and Seyed Esmaeel Shafiei; study supervision: Seyed Esmaeel Shafiei.

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